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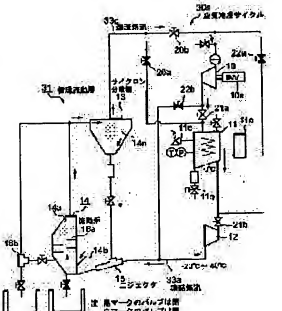
(54) METHOD AND APPARATUS FOR FREEZING/THAWING/POWDERING/ DRYING

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a method and an apparatus for freezing/thawing/powdering/ drying, enabling not only uniform and highly efficient removal of moisture but also pulverization at the time of the freezing and thawing of a charged wet member, bringing about the structural destruction of the charged member by the repetition of freezing and thawing to enable powdering and drying.
SOLUTION: The freezing/thawing/powdering/drying apparatus is constituted of an air freezing cycle 3a and a circulated fluidized bed 31 and a high speed air flow of low temperature freezing/high temperature thawing enabling heat transfer due to direct contact is formed in an air freezing cycle 30a using air as a cooling medium to be introduced into a circulating fluidized bed 31 having a circulating fluidizing medium, and the charged wet member is placed in a fluidized floating state and, through the repeated heat treatment of freezing/ thawing, the dehydration, pulverization and powder drying of the wet member are performed.



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CLAIMS

[Claim(s)]

[Claim 1] In the freeze-thawing powder desiccation approach which carries out freeze-thawing processing to a humid member, and considers dehydration and desiccation as detailed-ization of this member In the heat transfer device in which use an air refrigerating cycle for the heat source for freeze thawing which forms the freezing air current or fusion air current which contacts said humid member directly, and detailed-izing and solid liquid separation of said humid member are made to cause While constituting powder dry system using the circulation layer which is made to circulate through a bed material with the attached cyclone separator, and forms freezing/fusion fluid bed while introducing said freezing/fusion air current The freezing process of this member by the injection of the humid member to said freezing fluid bed, and an ice crystal and the separation process of freezing solid content, The collision destructive process of carrying out collision destruction of the separated ice crystal and the freezing solid content, and freezing operation constituted more, Discharge said system outside of the fusion water which changes and introduces a fusion air current in said circulation layer, was made to form the fusion fluid bed, was made to carry out heating fusion of the separated ice crystal and freezing solid content, and was obtained, The freeze-thawing powder desiccation approach of structure destruction being made causing in an injection humid member, and it having been made to carry out detailed-izing, and dehydration and desiccation, and preparing fusion operation to which discharge system outside of the water of condensation which takes out the generated fusion steam from a reflux air current out of a system is carried out, and carrying out as the description by the repeat of said freezing operation and fusion operation.

[Claim 2] The freeze-thawing powder desiccation approach according to claim 1 characterized by having made temperature of said freezing air current into abbreviation-20-40 degree C, and considering as the configuration in which fluid heat transfer in said freezing fluid bed is made to cause.

[Claim 3] The freeze-thawing powder desiccation approach according to claim 1 characterized by controlling the pressure of an intercooler so that frozen output air does not reach saturation temperature in said freezing operation when intercooler outlet air temperature of said air refrigerating cycle is made into 0 degrees C or more.

[Claim 4] In the freeze-thawing powder dryer which carries out freeze-thawing processing to an injection humid member, and considers dehydration and desiccation as detailed-ization of this member While introducing said freezing/fusion air current from the air refrigerating cycle which contacts said injection member directly and forms freezing / freezing/fusion air current to dissolve, and the lower part Join said introductory air current through an ejector in a bed material with the attached cyclone separator, circulate a fluidized bed furnace, and it freezes or dissolves [heating] through formed freezing/fusion fluid bed to an injection member. The circulation layer to which detailed-izing and moisture separation are carried out, and the freeze-thawing powder dryer characterized by having been alike and constituting powder dry system more.

[Claim 5] The freeze-thawing powder dryer according to claim 4 characterized by considering as the configuration which prepares the collision mold separator which consists of an eliminator for crushing in the heat flow rate circuit of said fluidized bed furnace.

[Claim 6] Said fluidized bed furnace is a freeze-thawing powder dryer according to claim 4 characterized by considering as the configuration which prepares the collision separator for ice crystal separation.

[Claim 7] The freeze-thawing powder dryer according to claim 4 characterized by constituting said air refrigerating cycle from a compression refrigeration cycle which consists of a compressor, an intercooler, and an expansion machine.

[Claim 8] The freeze-thawing powder dryer according to claim 4 characterized by constituting said air refrigerating cycle from a compression refrigeration cycle which consists of a compressor, a blower, an intercooler, and a cold energy heat exchanger for freezing.

[Claim 9] Said fusion air current is claim 4 characterized by constituting with the compressor regurgitation air which a compressor is made to inhale the air of a cyclone separator outlet via an intercooler through the bypass of compressor entry this side, and carries out the regurgitation, claim 7, and a freeze-thawing powder dryer according to claim 8.

[Claim 10] Said fusion air current is claim 4 characterized by considering as the configuration which makes the air which passed the compressor and the intercooler join the bed material of a direct cyclone separator, claim 7, and a freeze-thawing powder dryer according to claim 8.

[Claim 11] Said fusion air current is claim 4 characterized by considering as the configuration which makes the air which prepared the heat exchanger which carries out heat exchange to regurgitation compressed-air temperature in

the outlet of a compressor, and went via this heat exchanger join the bed material of a direct cyclone separator, claim 7, and a freeze-thawing powder dryer according to claim 8.
[Claim 12] Claim 4 characterized by preparing a water-of-condensation discharge device in said intercooler, claim 7, a freeze-thawing powder dryer according to claim 8.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention is a thing about freezing and fusion processing which are used for moisture removal and detailed-ized desiccation of sludge, a sludge, etc. of the humid member of difficulty dehydration nature. While attaining especially the increase in efficiency of freezing by direct contact of the freezing air current of the low temperature acquired by the air refrigerating cycle thru/or a hot fusion air current, and fusion in the heat source of freezing and fusion While making the quick-freezing of an injection member and detailed-izing by cellular fluidization by installation of the circulation layer which circulates the bed material which consists of heavy matter which attached the cyclone separator guide and aiming at generation separation of an ice crystal, and collision separation of freezing solid content Freezing and structure destruction of the injection member by repeating a series of processings of fusion are made to cause, and it is related with the freeze-thawing powder desiccation approach which enabled efficient dehydration and desiccation of unfree water, and its equipment.
[0002]
[Description of the Prior Art] If the sludge generated from coagulation sedimentation processing of waste water or activated sludge treatment, the sludge in which adsorption sedimentation deposition formation was carried out by waste fluid processing in the suspension particle in waste fluid remain as it is, dehydration is difficult and the freezing and thawing method which reforms colloid sludge as the solution means, and is improved from difficulty dehydration nature to I dehydration nature has been used. The method with which use of the heat pump method of the cold and warm temperature use of a refrigerator is generally performed, and cold energy is used for freezing and it uses the heat of compression for fusion is used for the refrigerating cycle of a freezing and thawing method. Moreover, the direct expansion type which contacts the evaporator of a refrigerator to sludge, and the indirect cooling system which carries out heat exchange to the antifreezing solutions, such as brine, and introduces this brine into a freezing tub are used for cooling system. And it is required that fusion can perform efficiently that stress concentrates neither on a cooling pipe nor a tub body by that the sludge in a and a tub is frozen in homogeneity, and there is no non-frozen part in a freezing tub, b, and freezing expansion of sludge, c, and freezing from the first etc.
[0003] It is proposed about the waste water treatment concerning said freezing and thawing method various recently also. For example, the proposal about waste water treatment is made to JP,2000-24645,A. According to this proposal, ice thermal storage is carried out using power-source waste heat, industrial waste heat, and the Nighttime power by using as an accumulation medium garbage wastewater, a waste, sanitary sewage, etc. which were ground by the grinder, and it is related with purification, waste water treatment equipment, and the waste-water-treatment approach of wastewater of having used the energy.
[0004] And about the waste-water-treatment approach, while carrying out the separation extract of the purification water at a high rate by repeating simple processing called freezing defrosting processing to wastewater containing a garbage object, and performing it to it, the deployment of the energy by ice thermal storage is measured collectively, performing the denaturation condensation and concentration of a garbage object etc. of a solid under wastewater. Therefore, two or more heat storage tanks which repeat freeze-thawing processing and perform it are prepared, the difference in the freezing velocity of a content formed element performs concentration separation one by one, and concentration of a formed element and the depression of freezing point of water are raised.
[0005] In addition, the interstitial water which encloses the perimeter of the particle of the solid with which solids, such as a ground garbage object, are in the suspension condition about said denaturation condensation according to explanation of the artificer concerned is frozen. Grow up this, condensation of a solids comrade, such as raw dust, and destruction of a cell wall are made to perform, intracellular internal unfree water is also dehydrated by this destruction, it is that to which a scale and solid liquid separation were made to perform coherent improvement and improvement in dehydration nature easily, and it is thought that it originates in the extracellular freezing by slow freezing. Freezing of long duration is required for structure destruction which originates in the extracellular freezing by such slow freezing, and it is difficult to freeze in homogeneity moreover.
[0006]
[Problem(s) to be Solved by the Invention] Use of a freezing and thawing method is faced the suspension particle in waste fluid as a means of difficulty dehydration nature solution of the sludge by which adsorption sedimentation deposition formation was carried out by the sludge generated from coagulation sedimentation processing of said conventional waste water or activated sludge treatment, and waste fluid processing. Although it is required that that

stress concentrates neither on a cooling pipe nor a tub body by that the sludge in a and a tub is frozen in homogeneity, and there is no non-frozen part in a freezing tub with the function of freezing dehydration which poses a problem, b, and freezing expansion of sludge, c, and freezing can improve [fusion] effectiveness from the first etc. It is in a situation without what solves the present condition and these conditions rationally.

[0007] This invention was made in view of said trouble, enables not only removal of the moisture of homogeneity quantity efficiency but detailed-ization on the occasion of freeze thawing of an injection humid member, it combines structure destruction of an injection member by the repeat of freeze thawing, is made to cause, and aims at offer of the freeze-thawing powder desiccation approach which enabled powder desiccation, and its equipment.

[0008]

[Means for Solving the Problem] Then, the freeze-thawing powder desiccation approach of this invention is set to the freeze-thawing powder desiccation approach which carries out freeze-thawing processing to a humid member, and considers dehydration and desiccation as detailed-ization of this member. In the heat transfer device in which use an air refrigerating cycle for the heat source for freeze thawing which forms freezing/fusion air current which contacts said humid member directly, and detailed-izing and solid liquid separation of said humid member are made to cause While constituting powder dry system using the circulation layer which is made to circulate through a bed material with the attached cyclone separator, and forms freezing/fusion fluid bed while introducing said freezing/fusion air current The freezing process of this member by the injection of the humid member to said freezing fluid bed, and an ice crystal and the separation process of freezing solid content, The collision destructive process of carrying out collision destruction of the separated ice crystal and the freezing solid content, and freezing operation constituted more, Change and introduce a fusion air current in said circulation layer, the fusion fluid bed is made to form, and heating fusion of the ice crystal and freezing solid content which were separated is carried out. Discharge system outside of fusion water. Fusion operation to which discharge system outside of the water of condensation which takes out the generated fusion steam from a reflux air current is carried out is prepared, and by the repeat of said freezing operation and fusion operation, structure destruction is made to cause in an injection humid member, and it carries out [that it was made to carry out detailed-izing, and dehydration and desiccation and] as the description.

[0009] The freeze-thawing powder desiccation approach of this invention dehydrates an injection humid member by freezing and fusion, makes efficient dehydration detailed to homogeneity in a freezing process, and is made to perform powder desiccation. That is, the air refrigerating cycle which uses air as a refrigerant is prepared for the heat sink for freezing and fusion, and the cold energy / warm temperature for fusion for freezing are efficiently given to it using the high-speed flow which contacts an injection member directly. moreover, to the means of communication which carries out heat transfer, said cold energy/warm temperature to an injection member The high-speed flow which consists of a cryogenic freezing air current / an elevated-temperature fusion air current which carries the cold energy/warm temperature from said air refrigerating cycle is obtained. It has the circulation layer which performs flow heat transfer through the bed material which consists of heavy matter by this high-speed flow. The powder dry system which is made to carry out flow circulation of said bed material through a cyclone separator by installation of the high-speed flow to this fluid bed, puts an injection member on floating, carries out efficient heat transfer, and enables the quick-freezing / rapid fusion by freezing/fusion fluid bed formation is formed.

[0010] And on the occasion of use, the freezing fluid bed is formed by introducing said high-speed freezing air current to a circulation layer. While the intracellular freezing and structure destruction by the quick-freezing are made to cause to the humid member supplied into the fluidized bed furnace, and making detailed-ization of a freezing member cause collectively The separation process in which vertical stratified separation is made to form the freezing process which performs generation of an ice crystal, and generation of freezing solid content, and the ice crystal generated at said freezing process and freezing solid content by flow of a bed material, Freezing operation which serves as more the collision destructive process of carrying out collision destruction of the separated ice crystal and the freezing solid content is prepared. While carrying out heating fusion of the ice crystal made separation detailed by said collision destructive process and the freezing solid content by the fusion fluid bed formed of installation of the high-speed fusion air current into a fluidized bed furnace and making fusion water discharge out of a system The reflux air current which flows back to an air refrigerating cycle is made to take the generated fusion steam along, and fusion operation made to discharge out of a system as the water of condensation with an intercooler is prepared. By the repeat of said freezing operation and fusion operation Structure destruction is made to cause in an injection humid member at homogeneity, and it is made to perform detailed-izing, and dehydration and powder desiccation.

[0011] In addition, although an injection member receives intracellular freezing in flow floating through the flowing low-temperature bed material by installation to said circulation layer of said high-speed cryogenic freezing air current In order said intracellular freezing has a quick cooling rate, to cool a cell too much before the balance of cell inside and outside by dehydration is acquired, and to bury the difference of chemical potential within and without a cell It points out that intracellular supercooling water is frozen in an instant, and intracellular freezing is taken into all living thing ingredients, and is also structure destruction of the fatal cell membrane itself. Generally the supercooling of a cell shall be cut with -20--40 degree C higher than -40 degrees C.

[0012] Moreover, the so-called thermal denaturation is made to cause to the ionic bond in intramolecular, hydrogen bond, and canal association by repeat actuation of freeze thawing to the injection member which consists of biopolymers, such as protein and a nucleic acid, and it is put on the condition that said association was cut.

[0013] Moreover, it is characterized by having made temperature of said freezing air current into abbreviation-20—40 degree C, and considering as the configuration in which fluid heat transfer in said circulation layer is made to cause.
[0014] Since intracellular freezing is made to cause like said bottom while temperature of the high-speed cryogenic freezing air current introduced into a circulation layer is made into abbreviation-20—40 degree C by said invention according to claim 2, and the heavy matter which is a bed material comes floating with this temperature and carrying out heat exchange, while an injection member is more efficient to homogeneity and freezing it, dehydration and detailed-ization of it are attained.
[0015] Moreover, in freezing operation, when intercooler outlet air temperature of said air refrigerating cycle is made into 0 degrees C or more, it is characterized by controlling the pressure of an intercooler so that frozen output air does not reach saturation temperature.
[0016] By said invention according to claim 3, the moisture within powder dry system can be condensed efficiently, and generating of the ice of the low-temperature air of an air refrigerating cycle can be prevented, and the dependability of equipment can be improved.
[0017] As opposed to said claims 1 and 2 and the freeze-thawing powder desiccation approach of three publications and the optimal freeze-thawing powder dryer In the freeze-thawing powder dryer which carries out freeze-thawing processing to an injection humid member, and considers dehydration and desiccation as detailed-ization of this member While introducing said freezing/fusion air current from the air refrigerating cycle which contacts said injection member directly and forms freezing / freezing/fusion air current to dissolve, and the lower part Join said introductory air current through an ejector in a bed material with the attached cyclone separator, circulate a fluidized bed furnace, and it freezes or dissolves [heating] through formed freezing/fusion fluid bed to an injection member. It is characterized by having resembled the circulation layer to which detailed-izing and moisture separation are carried out, and constituting powder dry system more.
[0018] Moreover, it is characterized by considering as the configuration which prepares the collision mold separator which consists of an eliminator for crushing in the heat flow rate circuit of said fluidized bed furnace.
[0019] Since the grinder which contained the eliminator for crushing etc. in the furnace wall of the riser part of a fluidized bed furnace in the shape of zigzag is formed by said invention according to claim 5, detailed-ization by separation with detailed-izing of an injection member, ice, and fine particles by the collision of fine particles and the collision with fine particles and ice can be performed, and improvement in the disintegration of drying efficiency and an injection member is obtained.
[0020] Moreover, said fluidized bed furnace is characterized by considering as the configuration which prepares the collision separator for ice crystal separation.
[0021] Moreover, it is characterized by constituting said air refrigerating cycle from an air compression refrigerating cycle which consists of a compressor, an intercooler, and an expansion machine.
[0022] Said invention according to claim 7 cools with an intercooler the regurgitation air which carried out inhalation compression and compressed air with the compressor at about 0 degree C through a chiller, carries out adiabatic expansion with an expansion machine, and has sent out high-speed cooling air.
[0023] Moreover, it is characterized by constituting said air refrigerating cycle from an air compression refrigerating cycle which consists of a compressor, a blower, an intercooler, and a cold energy heat exchanger for freezing.
[0024] Said invention according to claim 8 prepares the cold energy heat exchanger for freezing instead of an expansion machine in said invention according to claim 7, and prepares the blower for acceleration in the preceding paragraph of said intercooler.
[0025] Moreover, said claim 4, claim 7, and a fusion air current according to claim 8 are characterized by constituting with the compressor regurgitation air which a compressor is made to inhale the air of a cyclone separator outlet via an intercooler through the bypass of compressor entry this side, and carries out the regurgitation.
[0026] After discharging said invention according to claim 9 out of a system as the water of condensation by making it go via an intercooler immediately after coming out of cyclone separation the steam generated from the injection member contained in the reflux air current from a cyclone separator outlet, it is introduced to the ejector which bypassed the latter expansion machine and established the fusion air current which was made to go via a compressor and was dried before the direct circulation fluid bed.
[0027] Moreover, said claim 4, claim 7, and a fusion air current according to claim 8 are characterized by considering as the configuration which makes the air which passed the compressor and the intercooler join the bed material of a direct cyclone separator.
[0028] Said invention according to claim 10 makes the cold energy generating means of the last stage which constitutes an air refrigerating cycle bypass, forms a hot fusion air current, introduces it to the ejector before a circulation layer, and it is made to join the bed material from a cyclone separator.
[0029] Moreover, said claim 4, claim 7, and a fusion air current according to claim 8 prepare the heat exchanger which carries out heat exchange to regurgitation compressed-air temperature in the outlet of a compressor, and are characterized by considering as the configuration which makes the air which went via this heat exchanger join the bed material of a direct cyclone separator.
[0030] Said invention according to claim 11 uses the hot-pressing heat by the compressor as a heat source of a fusion air current.
[0031] Moreover, it is characterized by preparing a water-of-condensation discharge device in said claim 4, claim 7,

and an intercooler according to claim 8.
[0032]
[Embodiment of the Invention] Hereafter, this invention is explained to a detail using the example shown in drawing. However, the dimension of the component part indicated by the gestalt of this operation, the quality of the material, a configuration, its relative arrangement, etc. are not the meaning that limits the range of this invention only to it but only the mere examples of explanation, as long as there is no specific publication especially. Drawing 1 is the schematic diagram showing the configuration of the outline at the time of freezing operation of the freeze-thawing powder dryer of this invention, and drawing 2 is the schematic diagram showing the circuitry for the fusion air-current formation at the time of fusion operation of the air refrigerating cycle of drawing 1 . Drawing 3 is the schematic diagram showing the configuration of the outline of the air refrigerating cycle at the time of freezing operation in the case of using another example of the air refrigerating cycle of drawing 1 , and drawing 4 is the schematic diagram showing the circuitry for the fusion air-current formation at the time of fusion operation of the air refrigerating cycle of drawing 3 . Drawing 5 is the schematic diagram showing the configuration of the outline of the air refrigerating cycle at the time of freezing operation in the case of using another example of drawing 1 and the air refrigerating cycle of drawing 3 .
[0033] As shown in drawing 1 , it constitutes from air refrigerating cycle 30a and a circulation layer 31. The high-speed flow of the cryogenic freezing / elevated-temperature fusion which makes heat transfer by direct contact possible by air refrigerating cycle 30a which uses air as a refrigerant is formed. The humid member which introduced into the circulation layer 31 with the bed material through which it circulates, and was supplied to it is placed into flow floating, and it is made to perform dehydration [of said member], detailed-izing, and powder desiccation through repeat heat treatment of freezing/fusion.
[0034] So that it may see to drawing air refrigerating cycle 30a It constitutes from a compressor 10, an intercooler 11, and an expansion machine 12. At the time of freezing operation The elevated-temperature regurgitation air formed by the compressor 10 driven by inverter 10a is cooled at 0 degree C of abbreviation through chiller 11a with an intercooler 11. It is made the configuration which introduces the compressed air cooled by this intercooler 11 to the expansion machine 12, and obtains freezing air-current 33a of the high speed of optimum temperature to flow freezing of abbreviation-20-40 degree C by adiabatic expansion. When pressure exhaust pipe 11c and water-of-condensation exhaust valve 11b are prepared in said intercooler 11 and the outlet air temperature of an intercooler 11 becomes 0 degrees C or more, while carrying out pressure control and condensing the moisture in a system efficiently, it is made the configuration which prevents ice generating with the latter expansion machine 12.
[0035] Moreover, said circulation layer 31 consists of a fluidized bed furnace 14, a cyclone separator 13, and an ejector 15. It puts on a flow circulation condition by the high-speed flow for freezing/fusion which built in bed-material 14a which consists of heavy matter, and was introduced from the lower part, and the attached cyclone separator 13 separates from reflux air-current 33c, and a fluidized bed furnace 14 joins said high-speed flow through an ejector 15, and has been made the configuration which forms the circulation layer 31 which returns to a fluidized bed furnace again with the high-speed flow which joined. By circulation of said bed-material 14a, the humid member supplied from input port 14b is put on flow floating, and it has structure which made efficient heat transfer possible.
[0036] And if a humid member is supplied on the occasion of freezing operation in bed-material 14a which is in the low-temperature flow condition before and behind -35 degrees C of abbreviation by installation of freezing air-current 33a of the high speed of said low temperature, this injection member will receive the structure destruction which originates in the intracellular freezing by the quick-freezing, will carry out detailed-ized freezing, and will be made to divide it into the ice crystal and the freezing solid content which were further generated as a result of freezing. The separated ice crystal separates a part for ice through collision mold separator 16b prepared in the fluidized bed furnace 14, and is made to discharge it to ice extraction box 17a, collision crushing is carried out by prepared eliminator 16a for crushing, and freezing solid content is made detailed by the furnace wall, while carrying out an accompaniment rise flow at bed-material 14a which carries out a flow rise.
[0037] The installation to the circulation layer 31 of said after [freezing operation] freezing air-current 33a is stopped, popularity is won [b / fusion air-current 33] in supply from said air refrigerating cycle 30a, heating fusion of said freezing solid content by which freezing separation was carried out is carried out, and drip method sludge extraction box 17b is made to discharge as a drain the moisture contained in this freezing solid content. In addition, the fusion steam discharged at the time of fusion operation is along taken with reflux air-current 33c, results in an intercooler 11, and is discharged out of the system through water-of-condensation exhaust valve 11b.
[0038] in addition, the dissolver which holds the freezing solid content divided into the lower part of said fluidized bed furnace 14 at the time of said freezing operation — preparing — the time of fusion operation — said dissolver - a fusion air current — installation — warming — you may dissolve. A high-speed fusion air current becomes unnecessary, and it becomes unnecessary in this case, to warm a bed material again.
[0039] Said freezing air-current 33a is obtained from the air outlet of the expansion machine 12 by making the bulb of a black mark close in air refrigerating cycle 30a shown in drawing 1 . Fusion air-current 33b In air refrigerating cycle 30a shown in drawing 2 , the bulb of a black mark is made close. In bulb 20a, after a course, bypass a compressor 10 and reflux air-current 33c is resulted in an intercooler 11. It is made the configuration formed in a compressor 10 of a high-speed elevated-temperature air current via installation and bulb 22b via bulb 22a with this condensator 11 in dry air of 0 degree C of abbreviation which considered cooling as humidity removal.
[0040] The case where another example 30b of air refrigerating cycle 30a shown in drawing 1 is used for drawing 3

and drawing 4 is shown, and it is made the configuration which takes out the warm temperature of the hot-pressing regurgitation air of a compressor 10 by the heat exchanger 18. The case of freezing air-current 33a formation is shown in drawing 3 , and it is made for reflux air 33c to have outputted freezing air-current 33a of an abbreviation-20-40 degree C high speed from the expansion machine 12 via the compressor 10 and the intercooler 11 as close in the bulb of a black mark. Moreover, reflux air 33c which showed the case where a fusion air current was formed in drawing 4 using the same air refrigerating cycle 30b as drawing 3 , made bulb 21b close in this case, and went via the intercooler 11 is introduced into secondary [of a heat exchanger 18], it heats by the warm temperature of the regurgitation air of a compressor 10, and fusion air-current 33b has been obtained.

[0041] The situation of acquiring the freezing air current at the time of using another example 30c of the air refrigerating cycles 30a and 30b shown in said drawing 1 and drawing 3 for drawing 5 is shown. Air refrigerating cycle 30c in this case is constituted from a compressor 10, a blower 20 for acceleration, an intercooler 11, and a cold energy heat exchanger 19 for freezing so that it may see to drawing, and the abbreviation-20-40 degree C cryogenic freezing air current accelerated by said blower 20 from said reflux air-current 33c has been acquired. In addition, a fusion air current may use the heat exchanger of the compressor regurgitation elevated-temperature air shown in the bypass passage thru/or drawing 4 shown in said drawing 2 in this case.

[0042] Use the concentration sludge obtained by drip method sludge extraction box 17b which performs by turns said freezing operation and fusion operation which used freezing/fusion air current of the high speed obtained by said drawing 1 - drawing 5 , and is shown in said drawing 1 one after another, the structure destruction by thermal denaturation is made to cause in this sludge, and it is made the configuration carry out detailed-izing, dehydration, and powder desiccation as it is possible.

[0043]

[Effect of the Invention] Contain the ice crystal obtained after freezing an injection member enough, and the separated freezing solid content to lower fusion air-current induction, warm more than a melting out temperature, and it is made to discharge out of a system by using freezing unfree water as a drain, and enables it to have performed efficient fine-particles desiccation with the combination of the circulation layer and air refrigerating cycle which consist of a cyclone separator and a fluidized bed furnace in fine-particles desiccation by the above-mentioned configuration. Moreover, since collision blenders, such as an eliminator, are formed in the riser section of a fluidized bed furnace, detailed-ization by the collision of fine particles can be performed, and the improvement in the engine performance of drying efficiency and disintegration can be aimed at. Moreover, in an air refrigerating cycle, the by-pass operation of an expansion machine becomes possible, and continuation change operation to fusion operation which minds [said] the elevated-temperature fusion air current by change can do after freezing operation, and it becomes that it is possible in repeat operation with said freezing operation and fusion operation, and becomes that adjustment operation of aridity and fineness is possible. Moreover, a part for system inland water can be efficiently condensed by the pressure regulation of an intercooler, generating of the ice in the output side of a freezing air current is prevented, and the dependability of equipment can be improved.

[Translation done.]

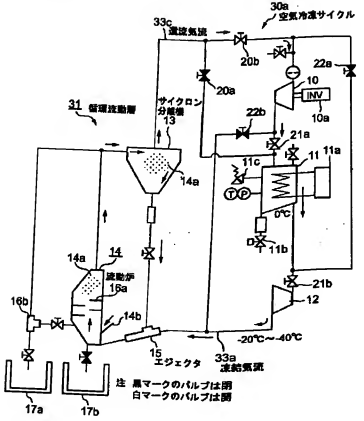
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the schematic diagram showing the configuration of the outline at the time of freezing operation of the freeze-thawing powder dryer of this invention.
[Drawing 2] It is the schematic diagram showing the circuitry for the fusion air-current formation at the time of fusion operation of the air refrigerating cycle of drawing 1 .
[Drawing 3] It is the schematic diagram showing the configuration of the outline of the air refrigerating cycle at the time of freezing operation in the case of using another example of the air refrigerating cycle of drawing 1 .
[Drawing 4] It is the schematic diagram showing the circuitry for the fusion air-current formation at the time of fusion operation of the air refrigerating cycle of drawing 3 .
[Drawing 5] It is the schematic diagram showing the configuration of the outline of the air refrigerating cycle at the time of freezing operation in the case of using another example of drawing 1 and the air refrigerating cycle of drawing 3 .
[Description of Notations]
10 Compressor
11 Intercooler
12 Expansion Machine
13 Cyclone Separator
14 Fluidized Bed Furnace
14a Bed material
14b Input port
15 Ejector
16a The eliminator for crushing
16b Collision mold separator
17a Ice extraction box
17b Drip method sludge extraction box
18 Heat Exchanger
19 Cold Energy Heat Exchanger for Freezing
30a, 30b, 30c Air refrigerating cycle
31 Circulation Layer

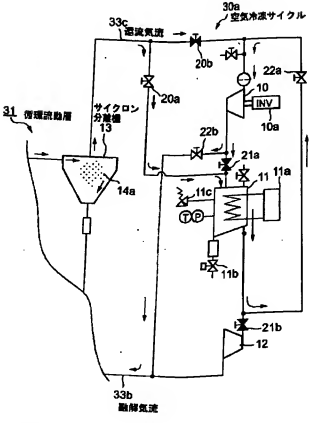
[Translation done.]

DRAWINGS

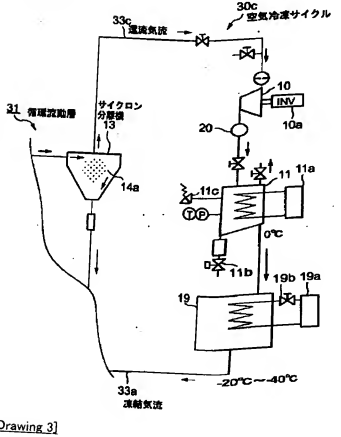
[Drawing 1]



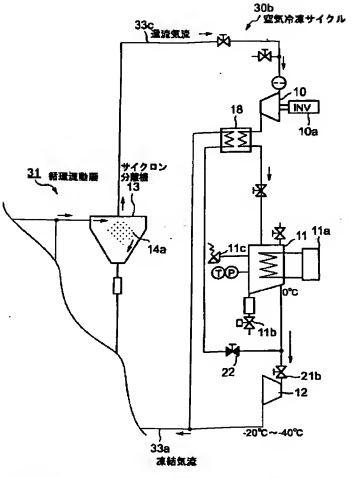
[Drawing 2]



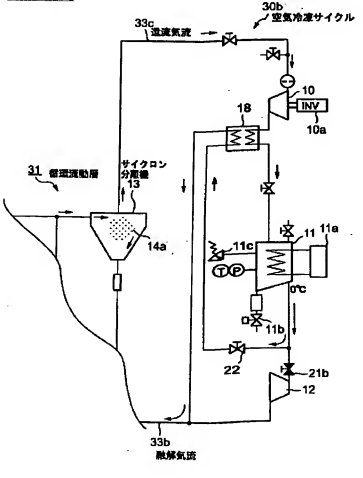
[Drawing 5]



[Drawing 3]


30b
空気冷凍サイクル
33c
通流気流
10
INV
10a
18
31
循環流動層
サイクロン
分離機
13
14a
11
11a
11c
T
P
0℃
11b
22
21b
12
-20℃～-40℃
33a
凍結気流

[Drawing 4]


30b
空気冷凍サイクル
33c
通流気流
10
INV
10a
18
31
循環流動層
サイクロン
分離機
13
14a
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11a
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T
P
0℃
11b
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21b
12
33b
融解気流

[Translation done.]

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Ｆ２５Ｂ　9/00	３０１	Ｆ２５Ｂ　9/00	３０１	４Ｄ０５９
Ｆ２５Ｊ　1/00		Ｆ２５Ｊ　1/00	Ａ	

審査請求　未請求　請求項の数12　ＯＬ　（全８頁）

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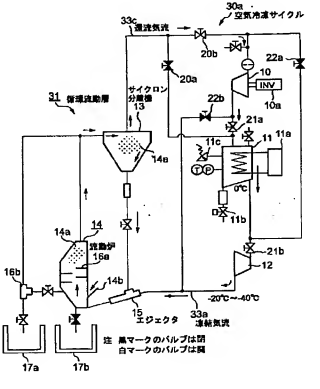
最終頁に続く

(54)【発明の名称】　凍結融解粉末乾燥方法とその装置

(57)【要約】
【課題】　投入湿潤部材の凍結融解に際して、均一高能率の水分の除去ばかりでなく微細化を可能とし、凍結融解の繰り返しにより投入部材の構造破壊を併せて惹起させ、粉末乾燥を可能とした凍結融解粉末乾燥方法とその装置を提供する。
【構成】　本発明の凍結融解粉末乾燥装置は、空気冷凍サイクル３０ａと循環流動層３１とより構成し、空気を冷媒とする空気冷凍サイクル３０ａで直接接触による伝熱を可能とする低温凍結／高温融解の高速気流を形成し、循環する流動媒体を持つ循環流動層３１に導入して、投入された湿潤部材を流動浮動状態のなかに置き、凍結／融解の繰り返し熱処理を介して前記部材の脱水、微細化、粉末乾燥を行なうようにしたものである。



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【特許請求の範囲】

【請求項１】　湿潤部材に凍結融解処理をして該部材の微細化と脱水、乾燥をする凍結融解粉末乾燥方法において、

前記湿潤部材に直接接触する凍結気流または融解気流を形成する凍結融解用熱源に空気冷凍サイクルを使用し、

前記湿潤部材の微細化と固液分離を惹起させる熱伝達機構には、前記凍結／融解気流を導入するとともに、付設したサイクロン分離機により流動媒体を循環させ凍結／融解流動層を形成する循環流動層を使用して粉末乾燥系を構成するとともに、

前記凍結流動層への湿潤部材の投入による該部材の凍結工程と、氷結晶と凍結固形分の分離工程と、分離した氷結晶と凍結固形分を衝突破壊させる衝突破壊工程と、より構成する凍結運転と、

前記循環流動層内に融解気流を切り替え導入して融解流動層を形成させ、分離した氷結晶及び凍結固形分の加熱融解をさせ、得られた融解水の前記系外排出と、発生した融解蒸気を還流気流より系外へ取り出す凝縮水の系外排出と、をさせる融解運転とを設け、

前記凍結運転と融解運転の繰り返しにより、投入湿潤部材に構造破壊を惹起させ、微細化と脱水、乾燥とを行なうようにしたことを特徴とする凍結融解粉末乾燥方法。

【請求項２】　前記凍結気流の温度を約－２０～－４０℃とし、前記凍結流動層における流動性熱伝達を惹起させる構成としたことを特徴とする請求項１記載の凍結融解粉末乾燥方法。

【請求項３】　前記凍結運転において、前記空気冷凍サイクルの中間冷却器出口空気温度を０℃以上にしたときには、冷凍出力空気が飽和温度に達しないように中間冷却器の圧力を制御するようにしたことを特徴とする請求項１記載の凍結融解粉末乾燥方法。

【請求項４】　投入湿潤部材に凍結融解処理をして該部材の微細化と脱水、乾燥をする凍結融解粉末乾燥装置において、

前記投入部材に直接接触して凍結／融解させる凍結／融解気流を形成する空気冷凍サイクルと、

下部より前記凍結／融解気流を導入するとともに、付設したサイクロン分離機により流動媒体をエジェクタを介して前記導入気流と合流して流動炉に循環させ、投入部材に対し、形成された凍結／融解流動層を介して凍結または加熱融解して、微細化と水分分離とをさせる循環流動層と、により粉末乾燥系を構成したことを特徴とする凍結融解粉末乾燥装置。

【請求項５】　前記流動炉の熱流循環路に破砕用エリミネータよりなる衝突型分離機を設ける構成としたことを特徴とする請求項４記載の凍結融解粉末乾燥装置。

【請求項６】　前記流動炉は、氷結晶分離用の衝突分離機を設ける構成としたことを特徴とする請求項４記載の凍結融解粉末乾燥装置。

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【請求項７】　前記空気冷凍サイクルを圧縮機、中間冷却器、膨張機からなる圧縮冷凍サイクルで構成したことを特徴とする請求項４記載の凍結融解粉末乾燥装置。

【請求項８】　前記空気冷凍サイクルを圧縮機、ブロワ、中間冷却器、凍結用冷熱熱交換器からなる圧縮冷凍サイクルで構成したことを特徴とする請求項４記載の凍結融解粉末乾燥装置。

【請求項９】　前記融解気流は、サイクロン分離機出口の空気を圧縮機入り口手前のバイパスを介して中間冷却器を経由して圧縮機に吸入させ吐出する圧縮機吐出空気により構成したことを特徴とする請求項４、請求項７、請求項８記載の凍結融解粉末乾燥装置。

【請求項１０】　前記融解気流は、圧縮機、中間冷却器を通過した空気を直接サイクロン分離機の流動媒体と合流させる構成としたことを特徴とする請求項４、請求項７、請求項８記載の凍結融解粉末乾燥装置。

【請求項１１】　前記融解気流は、圧縮機の出口に、吐出圧縮空気温度と熱交換する熱交換器を設け、該熱交換器を経由した空気を直接サイクロン分離機の流動媒体と合流させる構成としたことを特徴とする請求項４、請求項７、請求項８記載の凍結融解粉末乾燥装置。

【請求項１２】　前記中間冷却器に、凝縮水排出機構を設けたことを特徴とする請求項４、請求項７、請求項８記載の凍結融解粉末乾燥装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、汚泥やスラッジ等の難脱水性の湿潤部材の水分除去と微細化乾燥に使用する凍結、融解処理に関するもので、特に凍結、融解の熱源には空気冷凍サイクルにより得られた低温の凍結気流ないし高温の融解気流の直接接触による凍結、融解の効率化を図るとともに、サイクロン分離機を付設した重物質よりなる流動媒体を循環させる循環流動層の導入による、気泡流動化による投入部材の急速凍結と微細化を誘導させ、氷結晶の生成分離と凍結固形分の衝突分離を図るとともに、凍結、融解の一連の処理を繰り返すことによる投入部材の構造破壊を惹起させ、保有水の効率的脱水と乾燥を可能とした、凍結融解粉末乾燥方法とその装置に関する。

【０００２】

【従来の技術】廃水の凝集沈殿処理や活性汚泥処理から発生する汚泥や、廃液処理により廃液中の懸濁微粒子を吸着沈降堆積形成されたスラッジ等は、そのままでは脱水が困難で、その解決手段として、コロイド状汚泥を改質し難脱水性から易脱水性に改善する凍結融解法が使用されてきている。凍結融解法の冷凍サイクルには、冷凍機の冷・温熱利用のヒートポンプ方式の使用が一般的に行なわれ、凍結には冷熱を、融解には圧縮熱を利用する方式が使用されている。また冷却方式には、冷凍機の蒸発器を汚泥と接触させる直膨式と、ブラインなどの不凍

液と熱交換し、このブラインを凍結槽に導入する間接冷却方式が使用されている。そして、凍結槽には、

ａ、槽内の汚泥を均一に凍結し未凍結部分がないこと、

ｂ、汚泥の凍結膨張により冷却管や槽本体に応力が集中しないこと、

ｃ、凍結はもとより融解が効率よくできること、等が要求されている。

【０００３】前記凍結融解法に係わる排水処理に関しては、最近も種々提案されている。例えば、特開２０００－２４６４５号公報に排水処理に関する提案がされている。該提案によれば、粉砕機により粉砕された厨芥排水と雑排水及び汚水等を蓄熱媒体として、電源廃熱や工業廃熱及び夜間電力を利用して氷蓄熱をして、そのエネルギを利用した排水の浄化と排水処理装置と排水処理方法に関するものである。

【０００４】そして、その排水処理方法については、厨芥物を含む排水に凍結解凍処理という単純な処理を繰り返し行なうことにより、浄化水を高い割合で分離抽出するとともに、排水中の厨芥物等の固形物の変性凝集及び濃縮を行いながら、併せて氷蓄熱によるエネルギの有効利用をはかったものである。そのため、凍結融解処理を繰り返し行なう複数個の蓄熱槽を設け、含有固形成分の凍結速度の違いにより濃縮分離を順次行い、固形成分の濃縮と水の凝固点降下を高めている。

【０００５】なお、前記変性凝集については、当該発明者の説明によれば、粉砕された厨芥物等の固形物が懸濁状態になっている固形物の粒子の周囲を取り囲む間隙水を凍結させ、これを成長させ生鹿芥等固形物同志の凝集と細胞壁の破壊を行なわせ、該破壊により細胞内の内部保有水も脱水し、凝集性の向上と脱水性の向上をはかり、固液分離が容易に行なわれるようにしたもので、緩慢凍結による細胞外凍結に基因するものと考えられる。このような緩慢凍結による細胞外凍結に基因する構造破壊には長時間の凍結が必要で、しかも均一に凍結することは困難である。

【０００６】

【発明が解決しようとする課題】前記従来の廃水の凝集沈殿処理や活性汚泥処理から発生する汚泥や、廃液処理により廃液中の懸濁微粒子を吸着沈降堆積形成されたスラッジ等の、難脱水性解決の手段として凍結融解法の使用に際して、問題となる凍結脱水の機能を持つ凍結槽には、

ａ、槽内の汚泥を均一に凍結し未凍結部分がないこと、

ｂ、汚泥の凍結膨張により冷却管や槽本体に応力が集中しないこと、

ｃ、凍結はもとより融解が効率よくできること、

等が要求されているが、現状、これらの条件を合理的に解決するものがない状況である。

【０００７】本発明は、前記問題点に鑑みなされたもので、投入湿潤部材の凍結融解に際して、均一高能率の水分の除去ばかりでなく微細化を可能とし、凍結融解の繰り返しにより投入部材の構造破壊を併せて惹起させ、粉末乾燥を可能とした凍結融解粉末乾燥方法とその装置の提供を目的とするものである。

【０００８】

【課題を解決するための手段】そこで、本発明の凍結融解粉末乾燥方法は、湿潤部材に凍結融解処理をして該部材の微細化と脱水、乾燥をする凍結融解粉末乾燥方法において、前記湿潤部材に直接接触する凍結／融解気流を形成する凍結融解用熱源に空気冷凍サイクルを使用し、前記湿潤部材の微細化と固液分離を惹起させる熱伝達機構には、前記凍結／融解気流を導入するとともに、付設したサイクロン分離機により流動媒体を循環させ凍結／融解流動層を形成する循環流動層を使用して粉末乾燥系を構成するとともに、前記凍結流動層への湿潤部材の投入による該部材の凍結工程と、氷結晶と凍結固形分の分離工程と、分離した氷結晶と凍結固形分を衝突破壊させる衝突破壊工程と、より構成する凍結運転と、前記循環流動層内に融解気流を切り替え導入して融解流動層を形成させ、分離した氷結晶及び凍結固形分を加熱融解させ、融解水の系外排出と、発生した融解蒸気を還流気流より取り出す凝縮水の系外排出と、をさせる融解運転とを設け、前記凍結運転と融解運転の繰り返しにより、投入湿潤部材に構造破壊を惹起させ、微細化と脱水、乾燥とを行なうようにしたことを特徴とする。

【０００９】本発明の凍結融解粉末乾燥方法は、投入湿潤部材の脱水を凍結と融解により効率の良い脱水を行ない、凍結過程で均一に微細化して粉末乾燥を行なうようにしたものである。則ち、凍結と融解のための冷熱源には、空気を冷媒とする空気冷凍サイクルを用意して、投入部材に直接接触する高速気流を使用して凍結用冷熱／融解用温熱を効率良く与えるようにしてある。また、投入部材への前記冷熱／温熱を伝熱する伝達手段には、前記空気冷凍サイクルよりの冷熱／温熱を運搬する低温凍結気流／高温融解気流よりなる高速気流を得て、該高速気流により重物質よりなる流動媒体を介して流動伝熱を行なう循環流動層を備え、該流動層への高速気流の導入により前記流動媒体をサイクロン分離機を介して流動循環させ、投入部材を浮動状態に置き高効率の熱伝達をして、凍結／融解流動層形成による急速凍結／急速融解を可能にする粉末乾燥系を形成している。

【００１０】そして、使用に際しては、前記高速凍結気流を循環流動層へ導入することにより凍結流動層を形成して、流動炉内へ投入された湿潤部材に対し急速凍結による細胞内凍結と構造破壊を惹起させ、併せて凍結部材の微細化を惹起させるとともに、氷結晶の生成と凍結固形分の生成とを行なう凍結工程と、前記凍結工程で生成された氷結晶と凍結固形分とを流動媒体の流動により上下層状分離を形成させる分離工程と、分離した氷結晶と凍結固形分を衝突破壊させる衝突破壊工程と、よりなる

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凍結運転を設け、前記衝突破壊工程により分離微細化された氷結晶と凍結固形分を、流動炉内への高速融解気流の導入により形成された融解流動層により、加熱融解して融解水を系外へ排出させるとともに、発生した融解蒸気を空気冷凍サイクルへ還流する還流気流に帯同させ、中間冷却器で凝縮水として系外へ排出させる融解運転を設け、前記凍結運転と融解運転の繰り返しにより、投入湿潤部材に構造破壊を均一に惹起させ、微細化と脱水、粉末乾燥とを行なうようにしている。

【００１１】なお、前記高速低温凍結気流の前記循環流動層への導入により、流動する低温流動媒体を介して、投入部材は流動浮動状態のなかで細胞内凍結を受けるわけであるが、前記細胞内凍結は、冷却速度が速く、脱水による細胞内外の平衡が得られる前に、細胞が過度に冷却され、細胞内外に化学ポテンシャルの差を埋めるために、細胞内の過冷却水が瞬時に凍結することを指し、細胞内凍結はすべての生物材料に取って致命的である細胞膜自体の構造破壊でもある。細胞の過冷却は一般に－４０℃より高い－２０～－４０℃でおきるものとされている。

【００１２】また、凍結融解の繰り返し操作により、蛋白質や核酸などの生体高分子よりなる投入部材に対しては、分子内でのイオン結合、水素結合、疏水結合に対し所謂熱変性を惹起させ、前記結合が切断された状態に置かれる。

【００１３】また、前記凍結気流の温度を約－２０～－４０℃とし、前記循環流動層における流動性熱伝達を惹起させる構成としたことを特徴とする。

【００１４】前記請求項２記載の発明により、循環流動層に導入される高速低温凍結気流の温度は約－２０～－４０℃とし、該温度により流動媒体である重物質は浮き上がりながら熱交換をするとともに前記したように細胞内凍結を起こさせるため、投入部材はより均一に高効率で凍結するとともに、脱水及び微細化が可能となる。

【００１５】また、凍結運転において、前記空気冷凍サイクルの中間冷却器出口空気温度を０℃以上にしたときには、冷凍出力空気が飽和温度に達しないように中間冷却器の圧力を制御するようにしたことを特徴とする。

【００１６】前記請求項３記載の発明により、粉末乾燥系内の水分を効率良く凝縮でき、かつ、空気冷凍サイクルの低温空気の氷の発生を防止でき、装置の信頼性を向上できる。

【００１７】そして、前記請求項１、２、３記載の凍結融解粉末乾燥方法に対し、最適の凍結融解粉末乾燥装置は、投入湿潤部材に凍結融解処理をして該部材の微細化と脱水、乾燥をする凍結融解粉末乾燥装置において、前記投入部材に直接接触して凍結／融解させる凍結／融解気流を形成する空気冷凍サイクルと、下部より前記凍結／融解気流を導入するとともに、付設したサイクロン分離機により流動媒体をエジェクタを介して前記導入気流と合流して流動炉に循環させ、投入部材に対し、形成された凍結／融解流動層を介して凍結または加熱融解して、微細化と水分分離とをさせる循環流動層と、により粉末乾燥系を構成したことを特徴とする。

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【００１８】また、前記流動炉の熱流循環路に破砕用エリミネータよりなる衝突型分離機を設ける構成としたことを特徴とする。

【００１９】前記請求項５記載の発明により、流動炉のライザ部位の炉壁にジグザグ状に破砕用エリミネータ等を内蔵した粉砕機を設けてあるため、粉体の衝突による投入部材の微細化、氷と粉体との分離、粉体と氷との衝突による微細化が出来、乾燥効率、投入部材の粉末化の向上が得られる。

【００２０】また、前記流動炉は、氷結晶分離用の衝突分離機を設ける構成としたことを特徴とする。

【００２１】また、前記空気冷凍サイクルを圧縮機、中間冷却器、膨張機からなる空気圧縮冷凍サイクルで構成したことを特徴とする。

【００２２】前記請求項７記載の発明は、圧縮機で空気を吸入圧縮し、圧縮した吐出空気を中間冷却器でチラーを介して約０℃に冷却し、膨張機で断熱膨張させ、高速冷却空気を送り出すようにしてある。

【００２３】また、前記空気冷凍サイクルを圧縮機、ブロワ、中間冷却器、凍結用冷熱熱交換器からなる空気圧縮冷凍サイクルで構成したことを特徴とする。

【００２４】前記請求項８記載の発明は、前記請求項７記載の発明において膨張機の代わりに凍結用冷熱熱交換器を設け、前記中間冷却器の前段に加速用ブロワを設けたものである。

【００２５】また、前記請求項４、請求項７、請求項８記載の融解気流は、サイクロン分離機出口の空気を圧縮機入り口手前のバイパスを介して中間冷却器を経由して圧縮機に吸入させ吐出する圧縮機吐出空気により構成したことを特徴とする。

【００２６】前記請求項９記載の発明は、サイクロン分離機出口よりの還流気流に含まれる投入部材より発生した蒸気を、サイクロン分離を出た直後に中間冷却器を経由させることにより凝縮水として系外へ排出した後、圧縮機を経由させ乾燥した融解気流を後段の膨張機をバイパスして直接循環流動層の手前に設けたエジェクタへ導入するようにしたものである。

【００２７】また、前記請求項４、請求項７、請求項８記載の融解気流は、圧縮機、中間冷却器を通過した空気を直接サイクロン分離機の流動媒体と合流させる構成としたことを特徴とする。

【００２８】前記請求項１０記載の発明は、空気冷凍サイクルを構成する最終段の冷熱発生手段をバイパスさせ、高温の融解気流を形成して循環流動層の手前のエジェクタへ導入してサイクロン分離機よりの流動媒体と合流するようにしたものである。

【００２９】また、前記請求項４、請求項７、請求項８記載の融解気流は、圧縮機の出口に、吐出圧縮空気温度と熱交換する熱交換器を設け、該熱交換器を経由した空気を直接サイクロン分離機の流動媒体と合流させる構成としたことを特徴とする。

【００３０】前記請求項１１記載の発明は、圧縮機による高温圧縮熱を融解気流の熱源として利用するようにしたものである。

【００３１】また、前記請求項４、請求項７、請求項８記載の中間冷却器には凝縮水排出機構を設けたことを特徴とする。

【００３２】

【発明の実施の形態】以下、本発明を図に示した実施例を用いて詳細に説明する。ただし、この実施の形態に記載されている構成部品の寸法、材質、形状、その相対的配置などは特に特定的な記載がない限りは、この発明の範囲をそれのみに限定する趣旨ではなく、単なる説明例にすぎない。図１は本発明の凍結融解粉末乾燥装置の凍結運転時の概略の構成を示す系統図で、図２は図１の空気冷凍サイクルの融解運転時の融解気流形成のための回路構成を示す系統図である。図３は図１の空気冷凍サイクルの別の実施例を使用する場合の凍結運転時の空気冷凍サイクルの概略の構成を示す系統図で、図４は図３の空気冷凍サイクルの融解運転時の融解気流形成のための回路構成を示す系統図である。図５は図１、図３の空気冷凍サイクルの別の実施例を使用する場合の凍結運転時の空気冷凍サイクルの概略の構成を示す系統図である。

【００３３】図１に示すように、空気冷凍サイクル３０ａと循環流動層３１とより構成し、空気を冷媒とする空気冷凍サイクル３０ａで直接接触による伝熱を可能とする低温凍結／高温融解の高速気流を形成し、循環する流動媒体を持つ循環流動層３１に導入して投入された湿潤部材を流動浮動状態のなかに置き、凍結／融解の繰り返し熱処理を介して前記部材の脱水、微細化、粉末乾燥を行なうようにしたものである。

【００３４】図に見るように、空気冷凍サイクル３０ａは、圧縮機１０と中間冷却器１１と膨張機１２とより構成し、凍結運転時には、インバータ１０ａで駆動する圧縮機１０により形成された高温吐出空気を中間冷却器１１でチラー１１ａを介して略０℃に冷却し、該中間冷却器１１により冷却された圧縮空気を膨張機１２へ導入し断熱膨張により略－２０～－４０℃の流動凍結に最適温度の高速の凍結気流３３ａを得る構成にしてある。前記中間冷却器１１には圧力排出管１１ｃと凝縮水排出弁１１ｂを設け、中間冷却器１１の出口空気温度が０℃以上になったときは圧力制御し、系内の水分を効率よく凝縮するとともに、後段の膨張機１２での氷発生を防止する構成にしてある。

【００３５】また、前記循環流動層３１は、流動炉１４とサイクロン分離機１３とエジェクタ１５とより構成する。流動炉１４は、重物質よりなる流動媒体１４ａを内蔵し下部より導入された凍結／融解用の高速気流により流動循環状態に置き、付設したサイクロン分離機１３により還流気流３３ｃより分離して、エジェクタ１５を介して前記高速気流と合流し、合流した高速気流とともに流動炉に再び戻る循環流動層３１を形成する構成にしてある。前記流動媒体１４ａの循環流動により、投入口１４ｂから投入された湿潤部材を流動浮動状態に置き、高効率の熱伝達を可能にした構造となっている。

【００３６】そして、凍結運転に際しては、前記低温の高速の凍結気流３３ａの導入により略－３５℃前後の低温流動状態にある流動媒体１４ａの中に湿潤部材を投入すれば、該投入部材は急速凍結による細胞内凍結に基因する構造破壊を受け微細化凍結をし、さらには凍結の結果生成された氷結晶と凍結固形分に分離させる。分離された氷結晶は流動炉１４内に設けた衝突型分離機１６ｂを介して氷分を分離して氷採取箱１７ａへ排出させ、凍結固形分は流動上昇する流動媒体１４ａに帯同上昇流動する間に炉壁に設けた破砕用エリミネータ１６ａにより衝突破砕され微細化される。

【００３７】前記凍結運転後凍結気流３３ａの循環流動層３１への導入を停止させ融解気流３３ｂを前記空気冷凍サイクル３０ａより供給を受け、前記凍結分離された凍結固形分を加熱融解させ、該凍結固形分に含まれている水分はドレーンとしてドリップ式ヘドロ採取箱１７ｂに排出させる。なお、融解運転時に排出された融解蒸気は還流気流３３ｃとともに帯同され、中間冷却器１１に至り、凝縮水排出弁１１ｂを介して系外へ排出するようにしてある。

【００３８】なお、前記流動炉１４の下部に、前記凍結運転時に分離された凍結固形分を収容する溶解槽を設け融解運転時には前記溶解槽に融解気流を導入加温融解しても良い。この場合には高速の融解気流は不必要となりまた流動媒体を加温する必要なくなる。

【００３９】前記凍結気流３３ａは図１に示す空気冷凍サイクル３０ａにおいて、黒マークのバルブを閉として膨張機１２の空気出口より得るようにし、融解気流３３ｂは、図２に示す空気冷凍サイクル３０ａにおいて、黒マークのバルブは閉とし、還流気流３３ｃをバルブ２０ａを経由後、圧縮機１０をバイパスして中間冷却器１１に至り、該冷却器１１で湿度除去と冷却をした略０℃の乾燥空気をバルブ２２ａを経由して圧縮機１０へ導入、バルブ２２ｂを経由して高速高温気流により形成される構成にしてある。

【００４０】図３、図４には、図１に示す空気冷凍サイクル３０ａの別の実施例３０ｂを使用した場合を示し、圧縮機１０の高温圧縮吐出空気の温熱を熱交換器１８により取り出す構成にしてある。図３には凍結気流３３ａ形成の場合を示し黒マークのバルブは閉として、還流空気３３ｃは圧縮機１０、中間冷却器１１、を経由して膨

張機１２より略－２０～－４０℃の高速の凍結気流３３ａを出力するようにしてある。また、図４には図３と同一の空気冷凍サイクル３０ｂを使用して融解気流を形成する場合を示し、この場合はバルブ２１ｂを閉とし中間冷却器１１を経由した還流空気３３ｃを熱交換器１８の二次側に導入して圧縮機１０の吐出空気の温熱により加熱して融解気流３３ｂを得るようにしてある。

【００４１】図５には、前記図１、図３に示す空気冷凍サイクル３０ａ、３０ｂの別の実施例３０ｃを使用した場合の凍結気流を得る状況を示し、図に見るようにこの場合の空気冷凍サイクル３０ｃは圧縮機１０と加速用ブロワ２０と中間冷却器１１と凍結用冷熱熱交換器１９とより構成し、前記還流気流３３ｃより前記ブロワ２０により加速された略－２０～－４０℃の低温凍結気流を得るようにしてある。なお、この場合融解気流は前記図２に示すバイパス流路ないし図４に示す圧縮機吐出高温空気の熱交換器を使用しても良い。

【００４２】前記図１～図５で得られた高速の凍結／融解気流を使用した前記凍結運転と融解運転を交互に行い前記図１に示すドリップ式ヘドロ採取箱１７ｂで得られた濃縮ヘドロを次々に使用し、該ヘドロに熱変性による構造破壊を惹起させ、微細化と脱水と粉末乾燥を可能とする構成にしてある。

【００４３】

【発明の効果】上記構成により、粉体乾燥において、サイクロン分離機と流動炉よりなる循環流動層と空気冷凍サイクルとの組合せにより、投入部材を十分凍結した後得られた氷結晶と分離した凍結固形分を下部の融解気流導入部に収納して融解温度以上に加温し凍結保有水をドレーンとして系外に排出させ、高効率の粉体乾燥を行なうことができるようにしてある。また、流動炉のライザ部にはエリミネータ等の衝突破砕器を設けてあるため、粉体の衝突による微細化ができ、乾燥効率、粉末化の性能向上をはかることができる。また、空気冷凍サイクルにおいて、膨張機のバイパス運転が可能となり、凍結運転後、前記バイパス運転に切り替えによる高温融解気流

を介しての融解運転への連続切り替え運転が出来、且つ前記凍結運転と、融解運転との繰り返し運転が可能となり、乾燥度、粉末度の調整運転が可能となる。また、中間冷却器の圧力調整により系内水分を効率よく凝縮でき、凍結気流の出力側での氷の発生を防止し、装置の信頼性を向上できる。

【図面の簡単な説明】

【図１】　本発明の凍結融解粉末乾燥装置の凍結運転時の概略の構成を示す系統図である。

【図２】　図１の空気冷凍サイクルの融解運転時の融解気流形成のための回路構成を示す系統図である。

【図３】　図１の空気冷凍サイクルの別の実施例を使用する場合の凍結運転時の空気冷凍サイクルの概略の構成を示す系統図である。

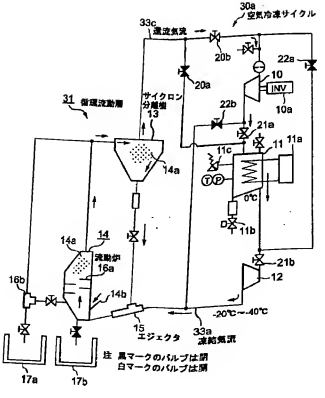
【図４】　図３の空気冷凍サイクルの融解運転時の融解気流形成のための回路構成を示す系統図である。

【図５】　図１、図３の空気冷凍サイクルの別の実施例を使用する場合の凍結運転時の空気冷凍サイクルの概略の構成を示す系統図である。

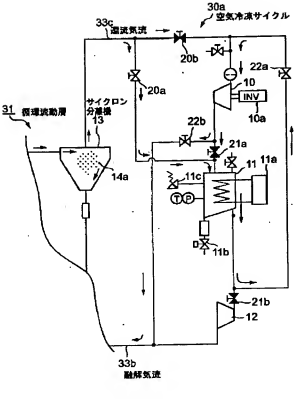
【符号の説明】

１０　　圧縮機
１１　　中間冷却器
１２　　膨張機
１３　　サイクロン分離機
１４　　流動炉
１４ａ　流動媒体
１４ｂ　投入口
１５　　エジェクタ
１６ａ　破砕用エリミネータ
１６ｂ　衝突型分離機
１７ａ　氷採取箱
１７ｂ　ドリップ式ヘドロ採取箱
１８　　熱交換器
１９　　凍結用冷熱熱交換器
３０ａ、３０ｂ、３０ｃ　　空気冷凍サイクル
３１　　循環流動層

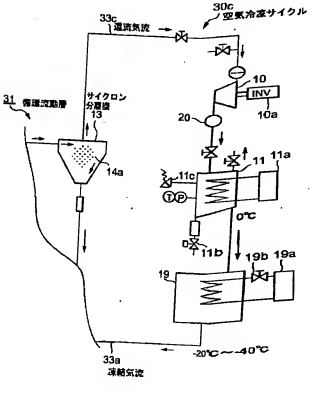
【図１】


30a
空気冷凍サイクル
33c
還流気流
20b
22a
10
INV
10a
20a
31 循環流動層
サイクロン
分離器
13
22b
21a
11
11a
11c
TP
0℃
D
11b
14a
14
流動炉
16a
16b
14b
21b
12
15
エジェクタ
-20℃～-40℃
33a
凍結気流
注 黒マークのバルブは開
白マークのバルブは閉
17a
17b

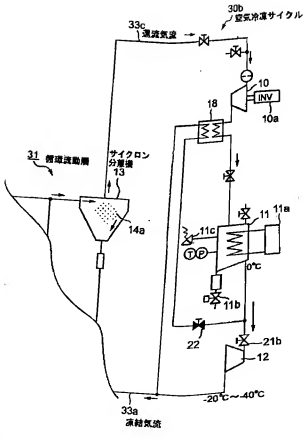
【図２】


30a
空気冷凍サイクル
33c
還流気流
20b
22a
10
INV
10a
20a
31 循環流動層
サイクロン
分離器
13
22b
21a
11
11a
11c
TP
D
11b
14a
21b
12
33b
融解気流

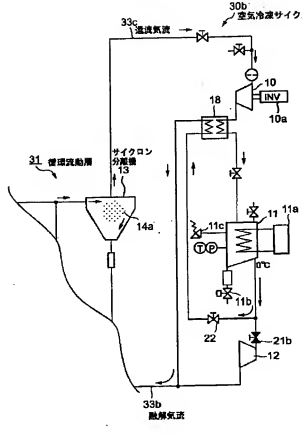
【図５】


30c
空気冷凍サイクル
33c
還流気流
10
INV
10a
31 循環流動層
サイクロン
分離器
13
20
11
11a
14a
11c
TP
0℃
D
11b
19b
19a
19
-20℃～-40℃
33a
凍結気流

【図３】



【図４】



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